

Barriers and Facilitators to HPV Vaccine Uptake among Adolescents in Sub-Saharan Africa: A Systematic Review

Paul Hassan Ilegbusi^{1,2,3*}, Abimbola Morolayo Olusuyi⁴, Everistus Tochukwu Chiakwa^{5,6,7}, Victor Adejare Adebisi⁸, Folake Risper Ayadi⁹, Modupe Elizabeth Ogunrinde⁴, Modupe Oluwakemi Soyemi¹⁰ and Oluwole Fayemi¹¹

¹Community Health Department, Ondo State College of Health Technology, Akure, Nigeria.

²Centre for Research Innovation Development and Entrepreneurship, United Kingdom.

³Department of Community Health Science, College of Community Health Sciences, Wesley University Ondo, Nigeria.

⁴Ekiti State College of Health Sciences and Technology, Ijero-Ekiti, Nigeria.

⁵Department of Dental Therapy, Faculty of Basic Medical Sciences, University of Ilesa, Osun State, Nigeria.

⁶Department of Health Sciences and Dentistry, Frontier University, Garowe, Somalia.

⁷Department of Dental Therapy, Millennium College of Health Technology, Akure, Nigeria.

⁸Data Analytics Department, Wetin Dey Code Academy, Akure, Ondo State, Nigeria.

⁹Coastline College of Health Technology, Okitipupa, Ondo State, Nigeria.

¹⁰POGIL College of Health Technology, Oke Eri, Ijebu-Ode, Ogun State, Nigeria.

¹¹School of Community Health, Lagos University Teaching Hospital, Idi-Araba, Lagos State, Nigeria.

***Corresponding author:** Paul Hassan Ilegbusi, Community Health Department, Ondo State College of Health Technology, Akure, Nigeria, Centre for Research Innovation, Development and Entrepreneurship, London, United Kingdom; Department of Community Health Science, College of Community Health Sciences, Wesley University, Ondo, Nigeria.

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ABSTRACT

Cervical cancer remains a leading cause of cancer-related mortality among women in sub-Saharan Africa, with Human Papillomavirus (HPV) infection being the primary etiological agent. HPV vaccination of adolescents represents a critical primary prevention strategy. However, vaccine uptake remains suboptimal across the region. Understanding the multi-level barriers and facilitators influencing HPV vaccine acceptance is essential for designing effective interventions to improve coverage. We conducted a systematic literature review following PRISMA 2020 guidelines. Comprehensive searches were performed across SciSpace (406 papers), Google Scholar (200 papers), and PubMed (109 papers) databases for studies published between 2010 and 2026. After removing 292 duplicates, 423 unique records underwent title/abstract screening using AI-assisted methodology with predefined inclusion and exclusion criteria scored on a 0-5 scale (threshold ≥ 4.0). Subsequently, 282 full-text articles were assessed (threshold ≥ 4.5), resulting in 222 studies included in the final synthesis. Data extraction focused on study design, geographic setting, target populations, barriers, facilitators, and vaccine uptake outcomes across individual, community, health system, and policy levels.

The 222 included studies spanned 12 sub-Saharan African countries, with the highest representation from Uganda, Kenya, Nigeria, Tanzania, Ethiopia, and South Africa. Major individual-level barriers included lack of knowledge about HPV and cervical cancer, fear of vaccine side effects, and concerns about early sexual debut. Community-level barriers encompassed cultural beliefs, religious objections, misinformation, and negative social norms. Health system barriers included vaccine stock-outs, inadequate healthcare worker training, poor accessibility in rural areas, and weak service delivery infrastructure. Policy-level barriers involved insufficient funding, lack of political commitment, and inadequate integration with existing immunization programs. Key facilitators included school-based vaccination delivery, parental education and awareness campaigns, healthcare provider recommendations, subsidized or free vaccination, community engagement, and strong political

will. Vaccine uptake rates varied widely from 3.6% to 96%, with school-based programs demonstrating higher coverage than facility-based approaches. HPV vaccine uptake among adolescents in sub-Saharan Africa is influenced by complex, multi-level factors. Successful interventions require comprehensive strategies addressing knowledge gaps, dispelling myths, strengthening health systems, ensuring vaccine availability and affordability, and leveraging school-based platforms.

Policy-makers should prioritize sustained funding, healthcare worker capacity building, community mobilization, and integration of HPV vaccination with broader adolescent health services. Future research should focus on implementation science, long-term sustainability of programs, and strategies to reach hard-to-reach populations, including out-of-school adolescents and rural communities.

Keywords: HPV Vaccine; Adolescents; Sub-Saharan Africa; Barriers; Facilitators; Vaccine Uptake; Cervical Cancer Prevention

Introduction

Rationale

Cervical cancer represents a significant public health challenge in sub-Saharan Africa, accounting for a disproportionate burden of cancer-related morbidity and mortality among women in the region. The disease is primarily caused by persistent infection with high-risk human papillomavirus (HPV) types, particularly HPV-16 and HPV-18, which are responsible for approximately 70% of cervical cancer cases globally. Despite being largely preventable through vaccination and screening, cervical cancer incidence and mortality rates in sub-Saharan Africa remain among the highest worldwide, with limited access to prevention and treatment services exacerbating the disease burden [1,2]. HPV vaccination represents a cornerstone of primary prevention against cervical cancer. The World Health Organization (WHO) recommends HPV vaccination for girls aged 9–14 years, ideally before sexual debut, as part of a comprehensive cervical cancer prevention strategy. The introduction of HPV vaccines in sub-Saharan African countries has been gradual, with many nations incorporating the vaccine into their national immunization programmes over the past decade [3,4]. However, vaccine uptake remains suboptimal across the region, with coverage rates varying widely between and within countries [5,6].

Multiple factors operating at individual, community, health-system, and policy levels influence HPV vaccine acceptance and uptake among adolescents in sub-Saharan Africa. Individual-level factors include knowledge and awareness about HPV and cervical cancer, perceptions of vaccine safety and efficacy, and concerns about potential side effects [1,7]. Community-level influences encompass cultural beliefs, religious perspectives, social norms, parental attitudes, and the role of misinformation and rumours [1,8]. Health-system factors include vaccine availability and accessibility, healthcare provider attitudes and recommendations, service-delivery models, and integration with existing health services [3,9–11]. Policy-level determinants involve national immunisation programme structures, funding mechanisms, political commitment, and implementation frameworks [3,12]. Understanding the complex interplay of barriers and facilitators

across these multiple levels is essential for designing and implementing effective interventions to improve HPV vaccine uptake.

While several individual studies have examined specific aspects of HPV vaccination in sub-Saharan African contexts, a comprehensive synthesis of the evidence is needed to inform policy and practice. This systematic review addresses this gap by synthesizing the available evidence on barriers and facilitators to HPV vaccine uptake among adolescents aged 9–19 years across sub-Saharan Africa.

Objectives

The primary objective of this systematic literature review is to comprehensively identify, synthesize, and analyze the barriers and facilitators influencing HPV vaccine uptake among adolescents in sub-Saharan Africa. Specifically, this review aims to address the following research questions:

- 1) What are the individual-level barriers and facilitators to HPV vaccine uptake among adolescents aged 9–19 years in sub-Saharan African countries?
- 2) What are the community-level barriers and facilitators (including cultural beliefs, social norms, and parental attitudes) that influence HPV vaccination acceptance among adolescents in sub-Saharan Africa?
- 3) What are the health system-level barriers and facilitators (including accessibility, availability, healthcare provider attitudes, and service delivery models) affecting HPV vaccine uptake among adolescents in sub-Saharan Africa?
- 4) What are the policy-level barriers and facilitators (including national immunization programs, funding mechanisms, and regulatory frameworks) that impact HPV vaccination coverage among adolescents in sub-Saharan Africa?
- 5) What is the relationship between identified barriers and facilitators and HPV vaccine uptake rates, acceptance, and hesitancy among adolescents in sub-Saharan African settings?

Methods

Protocol Registration

This systematic review was not prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO) or any other systematic review registry. Nevertheless, the review was conducted according to a predefined methodology developed before the commencement of the literature search. All review procedures were implemented consistently and reported in accordance with the PRISMA 2020 to ensure transparency and reproducibility.

Search Strategy

A comprehensive literature search was conducted across multiple databases to identify relevant studies examining barriers and facilitators to HPV vaccine uptake among adolescents in sub-Saharan Africa. The search strategy was designed to maximize coverage while maintaining relevance to the research questions.

Databases Searched

Three major databases were systematically searched:

- 1) **SciSpace:** Three search modalities were employed:
 1. Basic Search (2 queries, 100 papers each)
 2. Full Text Search (2 queries, 100 papers each)
 3. Library Search (2 queries, 3 papers each)
 4. Total retrieved: 406 papers
- 2) **Google Scholar:** Two comprehensive queries were executed, retrieving 100 papers per query (Total: 200 papers)
- 3) **PubMed:** Advanced search strategies using both MeSH terms and title/abstract keywords were employed across 2 queries (Total: 109 papers)

Search Terms

The search strategy incorporated multiple combinations of keywords and Boolean operators to capture relevant literature:

- Population terms: Adolescent, teenager, youth, "9-19 years", schoolgirls.
- Intervention terms: HPV, "human papillomavirus", vaccine, vaccination, immunization.
- Outcome terms: Barrier, facilitator, acceptance, hesitancy, uptake, "vaccination coverage", "vaccine acceptance".
- Geographic terms: "sub-Saharan Africa", "sub-Saharan Africa", SSA, Africa, specific country names.
- Level-specific terms: individual, community, "health system", policy, cultural, social norms, parental attitudes.

Date Range

The search covered studies published between 2010 and 2026, capturing the period following the introduction of HPV vaccines in sub-Saharan African countries.

Example Search Queries:

- **SciSpace Query 1:** "What are the barriers and facilitators to HPV vaccine uptake among adolescents in sub-Saharan Africa?"
- **Google Scholar Query 1:** "(HPV OR "human papillomavirus") AND (vaccine OR vaccination OR immunization) AND (barrier OR facilitator OR acceptance OR hesitancy OR uptake) AND (adolescent OR teenager OR youth) AND ("sub-Saharan Africa" OR "sub-Saharan Africa" OR SSA OR Africa)".
- **PubMed Query 1:** "(HPV[Title/Abstract] OR human papillomavirus[Title/Abstract]) AND (vaccine[Title/Abstract] OR vaccination[Title/Abstract] OR immunization[Title/Abstract]) AND (barrier[Title/Abstract] OR facilitator[Title/Abstract] OR acceptance[Title/Abstract] OR hesitancy[Title/Abstract] OR uptake[Title/Abstract]) AND (adolescent[Title/Abstract] OR teenager[Title/Abstract] OR youth[Title/Abstract]) AND (sub-Saharan Africa[Title/Abstract] OR Africa[Title/Abstract])".

Total Records Identified

The comprehensive search across all databases yielded 715 records. Following deduplication using automated tools and manual verification, 292 duplicate records were removed, resulting in 423 unique records for screening.

Eligibility Criteria

Studies were selected for inclusion based on predefined criteria aligned with the research questions and PICO framework (Population: adolescents aged 9-19 years in sub-Saharan Africa; Intervention: HPV vaccination programs; Comparison: not applicable; Outcomes: vaccine uptake, barriers, and facilitators).

Inclusion Criteria

- a) **Adolescent Target Group:** The study focuses specifically on adolescents aged 9 to 19 years or involves the primary decision-makers (parents, guardians, or teachers) regarding HPV vaccination for this age group. Studies examining perspectives of caregivers, healthcare workers, or policymakers were included if they directly addressed adolescent HPV vaccination.
- b) **Sub-Saharan African Geographic Focus:** The research is conducted within a country or region identified as part of sub-Saharan Africa and addresses local or national vaccination contexts. Studies conducted in multiple countries were

included if sub-Saharan African data could be extracted separately.

- c) **Multi-level Barriers and Facilitators:** The paper identifies specific individual, community, health system, or policy-level factors that either hinder or promote the uptake and acceptance of the HPV vaccine. Studies examining at least one level of influence were included.
- d) **HPV Vaccination Outcomes:** The study provides measurable or descriptive data on vaccine uptake rates, acceptance levels, or vaccine hesitancy specific to the HPV immunization program. Studies reporting qualitative or quantitative outcomes related to vaccination behavior were included.

Exclusion Criteria

- a. **Clinical Treatment Focus:** The study focuses primarily on the clinical treatment of HPV-related conditions, such as cervical cancer screening (Pap smears), cryotherapy, or oncology interventions, rather than primary prevention through vaccination. Studies were excluded if vaccination was not a primary focus.
- b. **General Immunization Infrastructure:** The study discusses general national immunization programs or other vaccines (e.g., polio, measles, COVID-19) without providing distinct, extractable data or insights regarding the HPV vaccine. Studies mentioning HPV vaccination only in passing were excluded.
- c. **Non-Regional Diaspora Populations:** The research focuses on sub-Saharan African diaspora or immigrant populations living in high-income countries outside of the sub-Saharan African geographic region. Studies conducted in Europe, North America, or other regions were excluded even if participants were of African descent.

Scoring Thresholds

An AI-assisted screening methodology was employed with equal-weight scoring across all criteria:

- Title/Abstract Screening Threshold: ≥ 4.0 out of 5.0.
- Each criterion was scored 0-1, with scores normalized to a 0-5 scale.
- Papers scoring ≥ 4.0 were considered to meet inclusion criteria sufficiently for full-text assessment
- Full-Text Screening Threshold: ≥ 4.5 out of 5.0.
- A higher threshold was applied at full-text stage to ensure only highly relevant studies were included in the final synthesis.
- Papers scoring ≥ 4.5 demonstrated strong alignment with all inclusion criteria.

Screening Process

A rigorous two-stage screening process was implemented to ensure systematic and transparent study selection.

Title and Abstract Screening

Following deduplication, 423 unique records underwent title and abstract screening. An AI-assisted screening methodology was employed using the predefined inclusion and exclusion criteria. Each paper was evaluated against all seven criteria (four inclusion, three exclusion), with each criterion scored on a 0-1 scale based on the degree to which the paper met or violated the criterion. Scores were then normalized to a 0-5 scale, with equal weighting applied to all criteria. Papers scoring ≥ 4.0 were deemed to have sufficient relevance and alignment with the review objectives to warrant full-text assessment. Papers scoring < 4.0 were excluded at this stage.

Results of Title/Abstract Screening

- 282 papers included (score ≥ 4.0)
- 141 papers excluded (score < 4.0)
- Top Reasons for Exclusion at Abstract Screening:
 - Not focused on adolescents in sub-Saharan Africa: 45 papers
 - Not specifically about HPV vaccination: 38 papers
 - No data on barriers/facilitators: 32 papers
 - Focused on clinical treatment rather than vaccination: 26 papers

Stage 2: Full-Text Screening

The 282 papers that passed title/abstract screening underwent full-text assessment. For papers with available full-text PDFs (27 papers), the AI-assisted screening was conducted using the complete manuscript, allowing for more detailed evaluation against the inclusion and exclusion criteria. For papers without accessible full-text PDFs (255 papers), the abstract screening scores were carried forward, and papers that had passed the abstract threshold were automatically included, as they had already demonstrated sufficient relevance. A higher threshold of ≥ 4.5 was applied at the full-text stage to ensure that only studies with strong alignment to all inclusion criteria and clear relevance to the research questions were included in the final synthesis.

Results of Full-Text Screening

- 222 papers included (score ≥ 4.5)
- 60 papers excluded (score < 4.5)
- Top Reasons for Exclusion at Full-Text Screening:
 - Insufficient data on barriers/facilitators: 22 papers

- Population outside target age range: 15 papers
- Geographic focus outside sub-Saharan Africa: 13 papers
- No extractable data on vaccine outcomes: 10 papers

Quality Assurance

The AI-assisted screening methodology employed consistent application of criteria across all papers, reducing potential reviewer bias. The two-stage process with increasing stringency thresholds ensured that only highly relevant studies were included in the final synthesis.

Data Extraction

Structured data extraction was performed on all 222 included studies using an AI-assisted methodology with access to full-text PDFs where available. Six key variables were systematically extracted to address the research questions:

- Study Design and Methods:** Type of study (e.g., cross-sectional, qualitative, mixed-methods, systematic review), sample size, data collection methods, and analytical approaches.
- Country and Setting:** Specific sub-Saharan African country or countries, geographic setting (urban, rural, or mixed), and study sites (e.g., schools, health facilities, communities).
- Target Population:** Characteristics of study participants including age range, sex, school enrollment status, and special populations (e.g., adolescents living with HIV, out-of-school youth).
- Key Barriers Identified:** Individual, community, health system, and policy-level barriers to HPV vaccine uptake, including specific factors such as knowledge gaps, cultural beliefs, access issues, and funding constraints.
- Key Facilitators Identified:** Individual, community, health system, and policy-level facilitators promoting HPV vaccine uptake, including factors such as awareness campaigns, school-based delivery, healthcare provider recommendations, and policy support.
- Vaccine Uptake Findings:** Quantitative data on vaccination

coverage rates, completion of vaccine series, and qualitative findings on acceptance and hesitancy patterns.

Data extraction focused on capturing both quantitative metrics (e.g., uptake percentages, odds ratios) and qualitative themes (e.g., cultural narratives, stakeholder perspectives) to enable comprehensive synthesis across diverse study designs. Where studies reported multiple outcomes or examined multiple levels of influence, all relevant data were extracted to ensure completeness.

Ethical Considerations

This study involved the systematic review and synthesis of data from previously published studies and did not involve direct contact with human participants, collection of primary data, or access to identifiable personal information. Therefore, ethical approval and informed consent were not needed. However, the review was conducted in accordance with internationally accepted principles of research integrity and ethical standards embodied in the Declaration of Helsinki. Similarly, the review adhered to the PRISMA 2020 guidelines to ensure transparency, accuracy, accountability, and reproducibility. All included studies were appropriately acknowledged through citation, and every effort was made to avoid plagiarism, selective reporting, and misrepresentation of published findings.

Results

Study Selection

The systematic search and screening process is summarized in the PRISMA 2020 flow diagram (Figure 1).

Identification: A total of 715 records were identified through database searches:

- **SciSpace:** 406 records
- **Google Scholar:** 200 records
- **PubMed:** 109 records

Screening: Following the removal of 292 duplicate records, 423 unique records underwent title and abstract screening. At this stage, 141 records were excluded based on the predefined inclusion and exclusion criteria (threshold score <4.0).

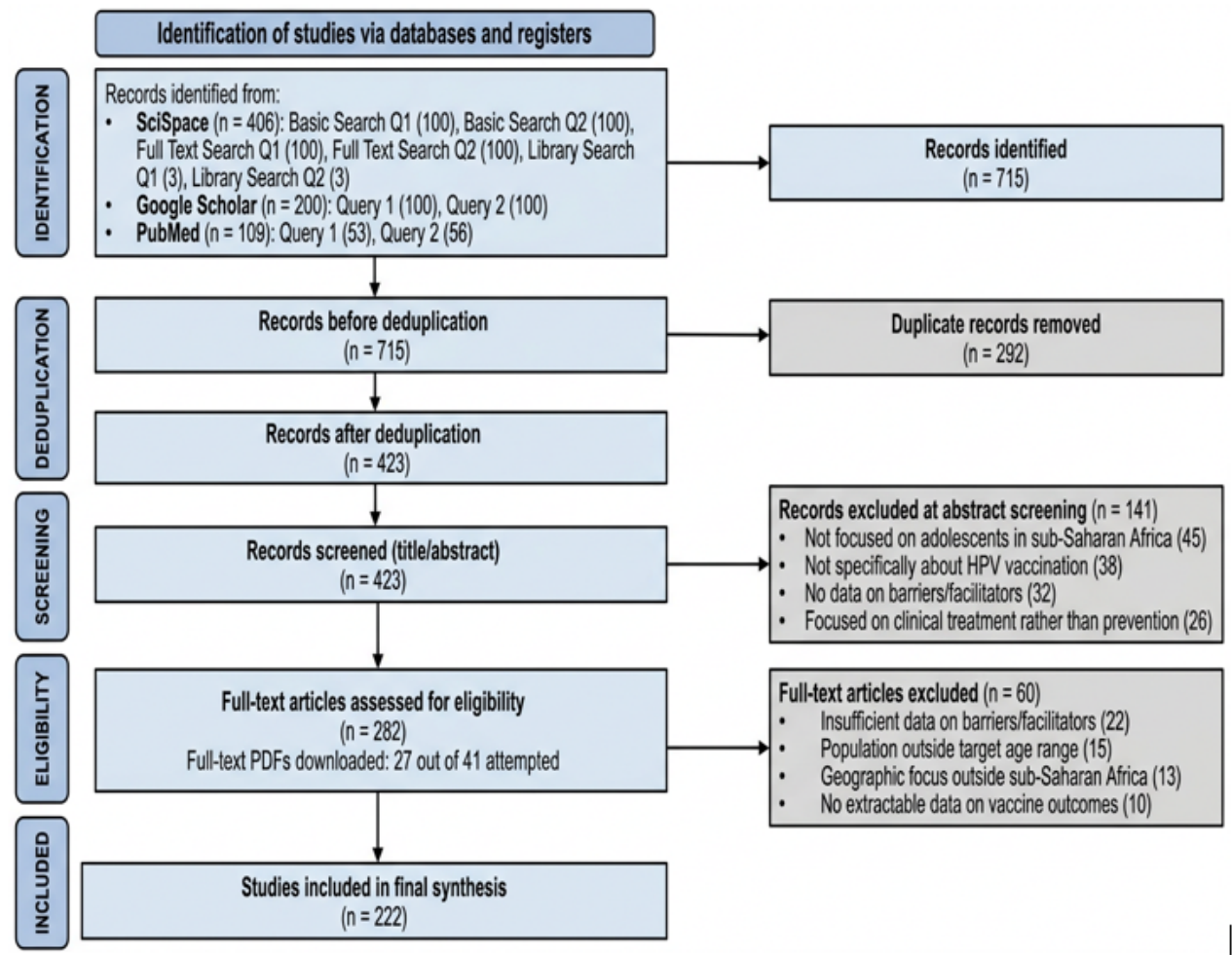


Figure 1: PRISMA 2020 Flow Diagram for Systematic Review of Barriers and Facilitators to HPV Vaccine Uptake Among Adolescents in Sub-Saharan Africa.

The primary reasons for exclusion at the abstract screening stage were:

- Not focused on adolescents in sub-Saharan Africa: 45 records (31.9%)
- Not specifically about HPV vaccination: 38 records (27.0%)
- No data on barriers/facilitators: 32 records (22.7%)
- Focused on clinical treatment rather than vaccination: 26 records (18.4%)

Eligibility: A total of 282 full-text articles were assessed for eligibility using a higher threshold score (≥ 4.5). At this stage, 60 articles were excluded.

The primary reasons for exclusion at the full-text screening stage were:

- Insufficient data on barriers/facilitators: 22 articles (36.7%)
- Population outside target age range: 15 articles (25.0%)
- Geographic focus outside sub-Saharan Africa: 13 articles (21.7%)
- No extractable data on vaccine outcomes: 10 articles (16.7%)

Included: A total of 222 studies were included in the qualitative and quantitative synthesis.

Study Characteristics

The 222 included studies exhibited diverse characteristics in terms of geographic distribution, study designs, target populations, and time periods.

Geographic Distribution

The included studies spanned 12 sub-Saharan African countries, reflecting the regional scope of HPV vaccination programmes. The geographic distribution was as follows:

- a) **Uganda:** The most frequently represented country, with multiple studies examining school-based vaccination programmes, rural-urban disparities, and special populations, including adolescents living with HIV [11,13-19].
- b) **Kenya:** Substantial representation with studies focusing on hard-to-reach populations, vaccine hesitancy, and implementation strategies [20-26].
- c) **Nigeria:** Multiple studies examining parental acceptance, vaccine rejection, misinformation, and innovative delivery models [27-36].
- d) **Ethiopia:** Numerous studies investigating knowledge, attitudes, uptake patterns, and cultural factors across different regions [7,37-49].
- e) **Tanzania:** Studies examining school-based programmes, implementation barriers, and stakeholder perspectives [2,50-54].
- f) **South Africa:** Research on programmatic challenges, vaccine hesitancy, and school-based delivery in both public and private schools [9,55-62].
- g) **Ghana:** Studies exploring adolescent perspectives, parental acceptance, and behavioural factors [63-66].
- h) **Malawi:** Research on vaccine hesitancy, enablers, and perspectives of adolescents living with HIV [67-69].
- i) **Zambia:** Studies on implementation strategies, parental consent, and health-system determinants [70,71].
- j) **Cameroon:** Research on successful vaccination campaigns, gender-neutral approaches, and parental attitudes [72-75].
- k) **Other countries:** Individual studies were identified from Senegal [76], Botswana [77], Rwanda [78], Mozambique [79], Zimbabwe [80], and Côte d'Ivoire [81].

Study Designs

The 222 included studies employed a range of research designs, reflecting the methodological diversity of the evidence on HPV vaccination in sub-Saharan Africa. The principal designs identified were cross-sectional studies, mixed-methods studies, qualitative studies, systematic reviews and meta-analyses, implementation-focused studies, and other observational or program-evaluation designs.

Cross-Sectional Studies

Cross-sectional studies constituted the most frequently represented design in the evidence base. These studies generally assessed

HPV vaccination knowledge, attitudes, willingness, uptake, vaccine hesitancy, associated factors, and determinants at a defined point in time. Examples included studies conducted among adolescent girls, parents and caregivers, healthcare workers, and community populations across Ethiopia, Uganda, Kenya, Tanzania, South Africa, Nigeria, and other countries [13,22,37,38,40,43,44,46,47,49,52,77,82-87].

Mixed-Methods Studies

Mixed-methods studies combined quantitative and qualitative approaches to provide a more comprehensive understanding of HPV vaccination uptake, barriers, facilitators, perceptions, and implementation experiences. These studies included research conducted in Nigeria, Malawi, Uganda, Ethiopia, and Tanzania [18,19,35,39,88].

Qualitative Studies

Qualitative studies were used to explore perceptions, beliefs, experiences, social and cultural influences, vaccine hesitancy, and implementation experiences among adolescents, parents, caregivers, healthcare workers, and other stakeholders. Common approaches included in-depth interviews, focus group discussions, and thematic or qualitative analysis. Examples included studies from Tanzania, Kenya, Ethiopia, Nigeria, Uganda, and Cameroon [23,29,51,54,72,89,90]. In addition, the rapid qualitative systematic review by [8] synthesized qualitative evidence concerning stakeholders' understandings of HPV vaccination in sub-Saharan Africa and was therefore considered separately as a review rather than as a primary qualitative study.

Systematic Reviews and Meta-Analyses

Several studies synthesized evidence from multiple primary studies through systematic reviews, meta-analyses, or scoping and rapid reviews. These studies examined HPV vaccine uptake, knowledge and attitudes, behavioral factors, vaccine hesitancy, social determinants, barriers and facilitators, communication strategies, and implementation approaches across sub-Saharan Africa and other low-resource settings [1,5-8,41,91-93].

Implementation Research and Program-Evaluation Studies

A substantial group of studies focused specifically on the implementation and delivery of HPV vaccination programmes. These studies examined national vaccine introductions, school-based delivery, health-system determinants, implementation barriers and facilitators, stakeholder perspectives, programme integration, and strategies for improving vaccine coverage. Relevant studies included work from several African countries, particularly Zambia, Tanzania, South Africa, Rwanda, and other sub-Saharan African settings [3,9,12, 54, 53,78,94].

Target Populations

The studies examined diverse populations within the adolescent age range and included adolescents, parents and caregivers, healthcare workers, and other community and programme stakeholders.

In-School Adolescent Girls (9–14 Years): In-school adolescent girls aged approximately 9-14 years constituted the primary target population in many studies of HPV vaccination uptake and school-based vaccination programmes [13,37,38,42,44,47,49,51,53,84,85,93,95].

Adolescent Girls Aged 13–19 Years: Several studies included older adolescent girls, including adolescents who may have been beyond the routine target age for HPV vaccination or who had missed earlier vaccination opportunities [60,90,96,97].

Parents and Caregivers: Parents and caregivers constituted an important population because they frequently influence or make vaccination decisions for adolescent girls. Studies examined their knowledge, perceptions, acceptance, willingness, hesitancy, beliefs, and consent regarding HPV vaccination [27-29,34,41,45,68,72,98,99].

Adolescents Living With HIV: Adolescents living with HIV represented a population with potentially distinct vaccination needs and barriers. Studies in Uganda and Malawi specifically examined HPV vaccination uptake, barriers, and strategies among adolescents living with HIV and/or their guardians [88,89,100].

Out-of-School and Hard-to-Reach Populations: Some studies focused on adolescents and communities that may be less accessible through conventional school-based vaccination programmes. These included hard-to-reach populations in Kenya and studies addressing access and attitudes toward HPV vaccination [25].

Healthcare Workers: Healthcare workers were examined as important actors in HPV vaccination because their knowledge, attitudes, recommendations, and involvement in programme delivery can influence vaccination uptake and implementation [11,101-103].

Policy-Makers and Programs Implementers: National and subnational policymakers, programme managers, and implementation stakeholders were represented in studies examining national HPV vaccine introduction, programme implementation, health-system determinants, and strategies for improving vaccination coverage [3,70,71,94,102].

Community Members and Other Stakeholders: Community-level stakeholders, including teachers, community health workers, religious or community leaders, parents, and other programme stakeholders, were included in studies examining community engagement, social influences, programme implementation, and HPV vaccine acceptability [19,51,54,73,104].

Time Periods: The included studies were published between 2016 and 2026, with the majority published after 2020, reflecting the increasing focus on HPV vaccination in sub-Saharan Africa following national program introductions. Studies examined vaccination programs at various stages of implementation, from pilot projects and demonstration programs to national rollout and routine immunization integration.

Synthesis of Evidence

The synthesis of evidence is organized according to the multi-level framework addressing individual, community, health system, and policy-level barriers and facilitators, followed by vaccine uptake patterns.

Individual-Level Barriers

Individual-level barriers to HPV vaccine uptake among adolescents in sub-Saharan Africa were consistently identified across multiple studies:

Knowledge Gaps: Lack of knowledge about HPV infection, cervical cancer, and HPV vaccination emerged as an important barrier to vaccine acceptance and uptake. Studies from Ethiopia reported associations between knowledge of HPV and HPV vaccination uptake, with inadequate knowledge identified among factors influencing vaccination behaviour [7,44,46]. In Nigeria, limited knowledge and awareness of HPV infection, cervical cancer, and HPV vaccination were identified as important factors influencing vaccine acceptance and uptake [33,105]. Similar relationships between knowledge, perceptions, and HPV vaccination uptake have been reported among adolescents in Uganda and other sub-Saharan African settings [15,16,106].

Fear of Side Effects: Concerns about vaccine safety and possible adverse effects represented an important individual-level barrier to HPV vaccination. In Ethiopia, concerns and fears surrounding HPV vaccination were reported among adolescents and parents, including concerns about vaccine safety and possible adverse consequences [38,106]. Nigerian studies similarly identified safety concerns, fear of adverse effects, and uncertainty about the vaccine as factors influencing acceptance and willingness to vaccinate [27,31,36]. In South Africa, misinformation and concerns surrounding HPV vaccine safety were associated with vaccine hesitancy and low vaccination coverage among caregivers and adolescent girls [56-58]. In Tanzania, concerns about vaccination and barriers to completing the HPV vaccine schedule have also been documented [52,53].

Misconceptions and Myths: Misconceptions and misinformation surrounding HPV vaccination were recurring barriers to vaccine acceptance. Across sub-Saharan Africa, reported misconceptions included concerns about vaccine safety, fertility, sexual behaviour, the necessity of vaccination, and the perceived consequences of vaccination [1,8,107]. In Ethiopia, rumors and fears surrounding HPV vaccination, including concerns about possible harmful effects, were reported among adolescent girls [108,109]. Nigerian studies similarly documented misconceptions concerning HPV vaccination, including concerns about sexuality, vaccine safety, and the perceived need for vaccination [33,110]. In Kenya, vaccine hesitancy was associated with parental knowledge, beliefs, concerns, and trust in the vaccine [23,99].

Perceived Susceptibility: Perceptions of personal susceptibility to HPV infection and cervical cancer influenced motivation to receive HPV vaccination. Studies examining HPV vaccination perceptions have indicated that adolescents and parents may perceive the risk of HPV infection or cervical cancer as low, particularly when vaccination is viewed as unnecessary for younger adolescents [1,7]. In South Africa, HPV and cervical cancer risk perceptions were found to be relevant to vaccine acceptability among adolescent girls and young women [59]. Similarly, studies using behavioral and health-belief perspectives have identified perceived risk and perceived benefits as relevant considerations in HPV vaccination decisions [12,65].

Age and Developmental Factors: Age and developmental stage influenced HPV vaccination decision-making and access. Younger adolescents, particularly those within the routine vaccination age range, commonly depended on parents or caregivers for consent and vaccination decisions [19,45]. For older adolescents, missed opportunities may arise where vaccination programmes are primarily delivered through schools or target specific age groups. Studies from Uganda and South Africa have documented barriers related to age, school attendance, access, and programme eligibility [13,15,60].

Socioeconomic Factors: Socioeconomic and structural circumstances influenced access to and uptake of HPV vaccination. Evidence from sub-Saharan Africa indicates that socioeconomic status, household circumstances, geographic accessibility, and other social determinants can influence vaccination uptake [5,6,91]. Studies from Uganda and other African settings similarly identified socioeconomic and access-related characteristics among factors associated with HPV vaccination uptake [15,87]. In Nigeria, barriers relating to access, awareness, parental perceptions, and health-system factors have also been documented [27,35].

Community-Level Barriers

Community-level factors significantly influenced HPV vaccine acceptance and uptake:

Cultural Beliefs and Norms: Cultural beliefs and social norms concerning sexuality, adolescence, and disease prevention shaped attitudes toward HPV vaccination. Ethiopian research identified cultural and social factors, including stigma surrounding discussions of sexuality and reproductive health, as influences on HPV vaccine acceptance [39,109]. In Nigeria, cultural interpretations linking cervical cancer with sexual behaviour and promiscuity have also influenced perceptions of HPV vaccination [110]. Ugandan research similarly identified sociocultural perceptions surrounding HPV, sexuality, and vaccination as factors affecting acceptability [19,90].

Religious Objections: Religious beliefs and faith-based concerns influenced HPV vaccination decisions in some settings. Nigerian research documented concerns surrounding HPV vaccination within communities, including perceptions linking vaccination with adolescent sexual behaviour and morality [34,36,110]. Ethiopian research

likewise identified faith, stigma, and concerns surrounding sexuality as factors influencing HPV vaccine acceptance [109]. Research from Cameroon further highlights the importance of understanding community and religious perspectives when implementing HPV vaccination programmes and addressing vaccine hesitancy [72].

Parental Attitudes and Decision-Making: Parental attitudes and decision-making were important determinants of adolescent HPV vaccination. Studies across several countries demonstrated that parental knowledge, beliefs, willingness, acceptance, and consent were closely related to vaccination decisions [27,28,41,42,98,99]. Negative parental attitudes, particularly when associated with misinformation, safety concerns, or vaccine hesitancy, could prevent or delay vaccination [29,36,58]. Conversely, positive parental knowledge, acceptance, and willingness to vaccinate facilitated HPV vaccine uptake [41,45].

Misinformation and Rumors: Community-level misinformation and rumors represented important barriers to HPV vaccination. South African studies documented misinformation and vaccine hesitancy related to concerns about HPV vaccine safety, effectiveness, and potential consequences, particularly among caregivers and communities in private-school settings [57,58]. Ethiopian research similarly documented rumors and fears surrounding HPV vaccination among adolescent girls, including concerns about potential harmful effects [107]. Nigerian studies identified misinformation, concerns about vaccine safety, and vaccine rejection as challenges to HPV vaccination programmes [34,36].

Social Norms and Peer Influence: Social norms, peer relationships, and social support influenced HPV vaccination attitudes and decisions. In Uganda, peer-to-peer education was examined as an approach for improving HPV vaccine acceptance among adolescent girls, suggesting the potential value of peer influence in promoting vaccination [104]. Ghanaian research similarly examined adolescent perspectives and behavioral factors associated with HPV vaccination intentions and acceptance [63,65,66]. More broadly, evidence from sub-Saharan Africa indicates that social norms and interpersonal influences can either facilitate or impede HPV vaccine acceptance and uptake [8,108].

Gender Norms: Gender-related norms influenced HPV vaccination, particularly in relation to communication about sexuality and reproductive health. Reviews and qualitative studies from sub-Saharan Africa have identified gender, sexuality, social expectations, and communication about HPV as relevant sociocultural considerations in HPV vaccination programmes [1,8]. Qualitative research in Uganda also highlighted the implications of perceptions surrounding sexuality and HPV vaccination for vaccine acceptability among adolescent schoolgirls [90]. In Cameroon, research has specifically examined perceptions of a gender-neutral approach to HPV vaccination, demonstrating the importance of considering gender norms when designing and implementing vaccination strategies [74].

Community Engagement and Trust: Community engagement and trust were important components of successful HPV vaccination implementation. Studies of HPV vaccination programmes emphasized community mobilization, stakeholder engagement, communication, and involvement of local actors as mechanisms for improving acceptance and programme implementation [73,94,102]. Research examining programme implementation in Tanzania and other African settings similarly highlighted the importance of engaging community stakeholders and building trust in vaccination programmes [51,52]. Conversely, inadequate stakeholder engagement, implementation challenges, and weak health-system capacity can undermine HPV vaccination programmes [3,50,92].

Health System-Level Barriers:

Health system factors presented substantial barriers to vaccine uptake:

Vaccine Availability and Stock-outs: Inadequate vaccine supply and stock-outs were important health-system barriers to HPV vaccination. Nigerian studies identified vaccine availability and programme-delivery challenges that could prevent uptake even among families who were willing to vaccinate their children [32,35]. Tanzanian research similarly identified implementation and supply-related challenges affecting HPV vaccination programmes [102]. In Uganda, health-system and facility-level challenges, including difficulties with vaccine access and service delivery, were reported as barriers to HPV vaccination [11,111]. In Zambia, implementation research identified health-system and programme-level barriers that affected HPV vaccination delivery [92].

Accessibility and Geographic Barriers: Poor accessibility, particularly in rural and remote settings, hindered HPV vaccination. Research from Uganda identified geographic and access-related differences in HPV vaccination uptake, with rural populations experiencing greater challenges in accessing vaccination services [25,111]. Ethiopian studies similarly identified place of residence and health-care access as factors associated with HPV vaccination uptake [7,48]. In Kenya, studies involving hard-to-reach communities documented challenges associated with accessing HPV vaccination services and reaching eligible populations [25,112]. Tanzanian research also identified geographical and programme-delivery considerations affecting HPV vaccination coverage and implementation [2,50].

Healthcare Worker Factors: Healthcare workers played an important role in HPV vaccination delivery through their knowledge, attitudes, recommendations, and interactions with adolescents and caregivers. Nigerian research found that healthcare worker-related factors, including knowledge, confidence, and attitudes, influenced recommendations for HPV vaccination [10]. Studies from Uganda also identified healthcare workers as important influences on HPV vaccine uptake and highlighted health-system factors affecting vaccination delivery [11,19]. Tanzanian implementation research emphasized the

importance of stakeholder capacity and effective programme implementation [102]. At the broader African level, lessons from national HPV vaccine introductions highlighted the importance of stakeholder preparedness, health-system capacity, and implementation experience [3].

Service-Delivery Models: The model through which HPV vaccination is delivered can influence access and uptake. Evidence from sub-Saharan Africa has highlighted the advantages and challenges of school-based, facility-based, and integrated approaches to HPV vaccination [9,12,94]. School-based delivery has been particularly important because it can facilitate access to the target adolescent population, whereas reliance on health facilities may create additional access barriers for some adolescents. Studies from Uganda, South Africa, Tanzania, and other African settings have examined the role of school-based and integrated delivery approaches in improving vaccination coverage [55,54,113]. Integration of HPV vaccination with other adolescent health services has also been identified as a potential strategy for reducing missed opportunities and improving programme efficiency [9,114].

Infrastructure and Resources: Inadequate health infrastructure and limited programme resources can constrain HPV vaccination implementation. Studies from African countries have identified challenges relating to health-system capacity, programme resources, service delivery, transportation, logistics, and other implementation requirements [9,3,92,102]. These constraints may be particularly pronounced in rural and hard-to-reach settings, where geographic accessibility and health-service capacity can affect the delivery of vaccination services [11,23].

Weak Monitoring and Data Systems: Weak monitoring, information, and data systems can limit the ability of vaccination programmes to identify eligible adolescents, monitor vaccine uptake and completion, and identify gaps in coverage. Programme implementation literature has emphasized the importance of effective monitoring, coordination, information systems, and programme management for sustaining high HPV vaccination coverage [3,12,94]. Research on HPV vaccination implementation in South Africa and other African settings similarly highlighted the importance of programme monitoring and evaluation in understanding coverage and improving service delivery [9,55].

Policy-Level Barriers:

Policy-level factors influenced the success of HPV vaccination programs:

Insufficient Funding: Limited financial resources for vaccine procurement, programme implementation, and long-term sustainability represented important barriers to HPV vaccination programme implementation. Evidence from national HPV vaccine introductions in African countries highlighted the importance of adequate

financing and programme resources for successful implementation and sustainability [3]. Implementation research from Zambia similarly identified resource-related and health-system constraints affecting HPV vaccination delivery [92]. In South Africa, programme implementation research also identified resource and system-level challenges that could affect the delivery and sustainability of HPV vaccination [9]. Dependence on external support and the sustainability of programme financing were identified as important considerations in national HPV vaccination implementation [3,94].

Lack of Political Commitment: Political commitment and prioritization were important determinants of successful HPV vaccination program implementation. Evidence from national HPV vaccine introductions in six African countries emphasized the importance of government commitment, national leadership, and prioritization in establishing and sustaining vaccination programs [3]. Studies of HPV vaccination implementation in Zambia likewise identified political and institutional factors as important influences on program implementation [3]. More broadly, implementation research has demonstrated that sustained leadership and stakeholder commitment are necessary for maintaining HPV vaccination programs and achieving high coverage [94].

Weak Policy Frameworks: Clear national policies, implementation guidelines, program structures, and operational procedures are important for effective HPV vaccination delivery. Evidence from national vaccine introductions in Africa highlighted the importance of appropriate policy and program frameworks in supporting HPV vaccination implementation [3]. Implementation research in Zambia similarly examined policy and organizational determinants of HPV vaccination implementation and identified contextual factors affecting program delivery [92]. In South Africa, program-level research also highlighted the importance of appropriate organizational and policy arrangements for integrating HPV vaccination into adolescent health services [9].

Regulatory and Approval Delays: Regulatory and administrative processes can influence the timing and effectiveness of HPV vaccine introduction. Evidence from national HPV vaccine introductions in African countries highlighted the importance of regulatory preparedness, coordination, and timely implementation in establishing national HPV vaccination programs [3].

Inadequate Integration: Weak integration of HPV vaccination with existing immunization and adolescent health services can create missed opportunities and reduce programme efficiency. Studies have emphasized the potential value of integrating HPV vaccination with adolescent-friendly health services and other interventions targeting adolescents [9,114]. In Tanzania, research on integrated delivery of HPV vaccination with adolescent health services highlighted opportunities and challenges associated with combining vaccination with existing adolescent health platforms [54]. Evidence from national im-

plementation experiences also supports the importance of coordination and integration within existing health and immunization systems [3,94].

Limited Target Population Definition: Narrow program eligibility criteria and reliance on school-based delivery can create difficulties in reaching adolescents who are outside formal school settings. Research on HPV vaccination in Kenya and other African settings has highlighted challenges in reaching hard-to-reach populations and ensuring equitable access to vaccination services [25,26]. Studies of HPV vaccination programs have also identified school attendance and program access as important considerations when attempting to reach the full eligible population [13,55].

Individual-Level Facilitators:

Individual-level facilitators that promoted HPV vaccine uptake included the following:

Knowledge and Awareness: Good knowledge and awareness about HPV infection, cervical cancer, and HPV vaccination were consistently associated with more favorable vaccination attitudes and higher uptake. Ethiopian evidence has demonstrated an association between knowledge and HPV vaccination uptake, with knowledge identified as an important predictor of vaccination behaviour [7,44,46]. Nigerian research similarly identified awareness and knowledge of HPV and cervical cancer as important factors influencing HPV vaccine acceptance and uptake [33,35]. Evidence from Uganda and other sub-Saharan African settings further supports the importance of knowledge and awareness in shaping HPV vaccination decisions [1,13,15].

Positive Attitudes: Positive attitudes toward HPV vaccination facilitated acceptance and uptake. Ethiopian studies identified favorable attitudes toward HPV vaccination as an important determinant of vaccination behaviour [7,39,46]. Studies involving adolescents and parents in other African settings similarly demonstrated that favorable perceptions and attitudes toward HPV vaccination were associated with greater willingness to vaccinate and vaccine acceptance [41,45,63,65]. Broader evidence from sub-Saharan Africa also indicates that positive attitudes toward vaccine safety, effectiveness, and benefits can facilitate HPV vaccine uptake [1,8].

Perceived Benefits: Recognition of the benefits of HPV vaccination, particularly its potential to prevent cervical cancer and protect future health, encouraged vaccine acceptance. Studies examining adolescent and parental attitudes identified perceived benefits and the preventive value of HPV vaccination as important considerations in vaccination decisions [19,41,65]. Evidence from Uganda and other sub-Saharan African settings similarly indicates that understanding the protective benefits of HPV vaccination can contribute to vaccine acceptance and uptake [1,15].

Self-Efficacy and Empowerment: Adolescent engagement and participation in health decision-making can facilitate HPV vaccination, particularly where adolescents have access to appropriate information and supportive social environments. Research involving Ghanaian adolescents has examined behavioral factors, perceptions, and adolescent perspectives relevant to HPV vaccination decisions [63,65,66]. In Uganda, peer-to-peer education has also been investigated as a strategy for empowering adolescent girls and improving HPV vaccine acceptance [104].

Urban Residence: Urban residence was associated with higher HPV vaccination uptake in some settings, although the relationship varied across studies and may reflect differences in access to information, health services, education, and programme implementation. Ethiopian and Ugandan studies have examined geographic and residential factors in relation to HPV vaccination uptake [7,15]. Evidence synthesized across sub-Saharan Africa also indicates that geographic location and access to vaccination services can contribute to differences in uptake [1,5,6].

Community-Level Facilitators

Community-level facilitators that enhanced vaccine uptake included the following:

Parental Education and Support: Parental education and support regarding HPV, cervical cancer, and HPV vaccination were important facilitators of adolescent vaccination. Studies examining parents and caregivers found that greater knowledge, favorable attitudes, willingness to vaccinate, and supportive decision-making were associated with HPV vaccine acceptance and uptake [26,33,41,45,98,99]. Interventions and communication approaches that provided parents with information and addressed concerns about HPV vaccination were identified as potentially important strategies for improving acceptance [29,72].

Community Engagement and Mobilization: Active community engagement and mobilization, including involvement of community stakeholders and local leaders, facilitated HPV vaccination program implementation and acceptance. Evidence from Cameroon highlighted the importance of community and stakeholder engagement in successful HPV vaccination campaigns [73,75]. Tanzanian research similarly emphasized stakeholder engagement and community-level participation in HPV vaccination implementation [51,102]. In Uganda, community-based and peer-supported approaches have also been investigated as strategies for improving HPV vaccine acceptance among adolescents [19,104].

Peer Education and Support: Peer education and social support among adolescents can facilitate HPV vaccination acceptance. Ugandan research specifically examined peer-to-peer education as an approach for improving HPV vaccine acceptance among adolescent girls [104]. Ghanaian studies have also examined adolescent perspectives and behavioural factors relevant to HPV vaccination intentions and

acceptance, providing evidence for the importance of interpersonal and peer-related influences [63,65,66].

Positive Social Norms: Supportive social norms and community acceptance can facilitate HPV vaccination by creating an environment in which vaccination is viewed positively and is socially supported. Evidence from qualitative and systematic reviews in sub-Saharan Africa indicates that social norms, community perceptions, interpersonal relationships, and social support influence HPV vaccine acceptability and uptake [1,8,108]. Positive social environments may therefore help counter misinformation and reduce concerns surrounding HPV vaccination.

Engagement of Religious and Traditional Leaders: Engagement of influential community, religious, and traditional leaders can help address cultural and faith-related concerns surrounding HPV vaccination. Evidence from Cameroon emphasized the importance of community and stakeholder engagement in HPV vaccination programmes [72,73]. Broader evidence from sub-Saharan Africa also supports engagement with influential community stakeholders as part of strategies for addressing vaccine concerns and improving acceptance [1,8].

Media and Communication Campaigns: Effective communication strategies, including community outreach, interpersonal communication, mass communication, and other information-delivery approaches, can improve awareness and address concerns about HPV vaccination. Evidence from sub-Saharan Africa has highlighted communication and information as important components of HPV vaccination implementation and vaccine-acceptance strategies [3,8,94]. Studies examining HPV vaccine hesitancy have also emphasized the need for accurate information and targeted communication to address misinformation, safety concerns, and other barriers to acceptance [1,108].

Health System-Level Facilitators

Health system facilitators that promoted vaccine uptake included the following:

School-Based Vaccination Delivery: School-based vaccination emerged as an important and widely used delivery strategy for reaching adolescent girls and improving HPV vaccination coverage. School-based programs provide an efficient platform for reaching large numbers of eligible adolescents, reducing some geographical and access barriers, and facilitating delivery within an environment where the target population is concentrated [9,51,55,113]. Evidence from Uganda, Tanzania, and South Africa demonstrates the feasibility of school-based HPV vaccination and highlights its contribution to improving access and programme delivery [51,55,62,113]. Systematic and scoping reviews of HPV vaccination interventions in Africa likewise identify school-based delivery as an important strategy for reaching adolescents [12,115,116]. However, the evidence does not justify the blanket statement that school-based vaccination is uni-

versally “the most effective” strategy or that it consistently produces higher coverage than facility-based approaches.

Its effectiveness depends on school attendance, program organization, community acceptance, vaccine supply, and the availability of complementary approaches for adolescents who are not reached through schools [94,117].

Healthcare Provider Recommendations: Strong health-care-provider recommendations and effective communication with adolescents and caregivers can facilitate HPV vaccination. Nigerian research specifically identified factors influencing healthcare workers’ recommendations of HPV vaccination, including knowledge, beliefs, confidence, and other behavioral determinants [30]. A multi-country study of healthcare-provider perspectives similarly identified provider-related facilitators and barriers to HPV vaccine delivery [116]. Evidence from Kenya, India, and Nigeria further emphasized the importance of effective communication by healthcare workers in promoting HPV vaccination [118]. In Uganda, healthcare workers, community health workers, caregivers, and teachers were identified as important stakeholders in HPV vaccine initiation and completion [19]. Strengthening provider knowledge, communication skills, and confidence in addressing vaccine hesitancy can therefore support vaccine acceptance and uptake [101,119].

Free or Subsidized Vaccination: Provision of HPV vaccination at no or minimal cost can reduce financial barriers to vaccination, particularly where families would otherwise face direct or indirect costs associated with accessing vaccination services. Evidence from African HPV vaccination programs indicates that government-supported and donor-supported programs have generally facilitated access to HPV vaccination by reducing direct financial barriers [3,55,94]. Evidence on social and socioeconomic determinants further indicates that household socioeconomic circumstances can influence HPV vaccine access and uptake [91,120].

Integration with Existing Services: Integration of HPV vaccination with existing school health programs, adolescent health services, and other preventive interventions can improve program efficiency and facilitate access to adolescents. In South Africa, integration with adolescent health services has been identified as an opportunity for strengthening HPV vaccination programs [9]. In Tanzania, stakeholders examined the feasibility and sustainability of integrating HPV vaccination with adolescent health services through a school-based platform [54]. The experience of Togo similarly demonstrates the potential of integrated HPV vaccination approaches for promoting adolescent health [114]. Evidence from other implementation studies supports coordination and integration with existing health and immunization systems as an important program strategy [3,94].

Outreach and Mobile Services: Outreach and alternative delivery approaches can improve access to adolescents who are not adequately reached through routine school-based or facility-based

services. Kenyan research specifically examined access to HPV vaccination among hard-to-reach populations and identified challenges associated with reaching underserved communities [25]. More recent evidence has highlighted the need for delivery strategies that specifically address out-of-school girls and other populations who may be missed by school-based programs [117]. In Uganda, community-based and peer-supported approaches have also been investigated as mechanisms for extending HPV vaccine information and acceptance among underserved adolescent populations [104]. In addition, mobile and digital approaches may complement conventional vaccination delivery. A randomized controlled trial in Nigeria evaluated the effect of mobile health technologies on HPV vaccine uptake among mothers of vaccine-eligible girls, demonstrating the growing role of digital approaches in supporting vaccination uptake [121].

Strengthened Supply Chain and Logistics: Reliable vaccine supply, appropriate logistics, and adequate programme infrastructure are essential for successful HPV vaccination implementation. Evidence from national HPV vaccine introductions in African countries identified program preparedness, supply, logistics, health-system capacity, and coordination as important implementation considerations [3]. Tanzanian implementation research similarly identified programme and health-system factors affecting HPV vaccination delivery [102]. Implementation research from Zambia also identified health-system and contextual determinants that influence HPV vaccination implementation [12]. Broader reviews of HPV vaccination implementation in sub-Saharan Africa reinforce the importance of adequate resources, logistics, infrastructure, and health-system capacity [94,122,123].

Monitoring and Feedback Systems: Robust monitoring and information systems are important for tracking vaccination coverage, identifying missed opportunities, monitoring program performance, and directing corrective interventions. Evidence from national HPV vaccination program introductions and implementation research emphasizes the importance of program monitoring, coordination, data use, and evaluation in achieving and sustaining high vaccination coverage [3,92,94]. Program evaluations, including the South African national school-based vaccination campaign, also demonstrate the importance of monitoring implementation and coverage to identify program strengths and challenges [55].

Policy-Level Facilitators

Policy-level facilitators that supported HPV vaccination programs included:

Strong Political Commitment: High-level political commitment and effective leadership are important facilitators of successful HPV vaccination program implementation. Political commitment can support program prioritization, intersectoral coordination, resource mobilization, and sustained implementation. Evidence from the introduction of HPV vaccination programs in six African countries identified stakeholder engagement, political and program leadership, and

national commitment as important components of successful vaccine introduction [3]. Similarly, implementation research from Rwanda and broader evidence on sustaining high HPV vaccination coverage highlight the importance of strong program leadership and supportive implementation environments [78,94]. Evidence from Tanzania also demonstrates the importance of engagement across national, subnational, and community levels in facilitating HPV vaccination implementation [50].

Adequate Funding and Resource Allocation: Adequate and sustainable financing is essential for vaccine procurement, program implementation, workforce capacity, logistics, communication, monitoring, and long-term program sustainability. Evidence from African HPV vaccine introductions has highlighted the importance of financial and program resources in supporting implementation [3]. Studies examining HPV vaccination implementation in Zambia and Tanzania similarly identified resource availability and health-system capacity as important determinants of program implementation [92,102]. Regional evidence further indicates that sustainable financing and adequate resource allocation are necessary for maintaining high HPV vaccination coverage in low-resource settings [94,122,123].

Clear Policy Frameworks and Guidelines: Clear national policies, implementation guidelines, operational procedures, and defined program responsibilities facilitate coordinated and consistent HPV vaccination implementation. Evidence from African countries indicates that national policy development, program planning, stakeholder coordination, and clearly defined implementation processes are important components of successful HPV vaccine introduction [3]. Research from Zambia further demonstrates that implementation determinants operate across multiple levels of the health system and that appropriate implementation strategies are required to translate national HPV vaccination policies into effective programme delivery [92]. Reviews of implementation strategies in sub-Saharan Africa similarly emphasize the importance of structured programme planning and contextually appropriate implementation approaches [12,94].

Multi-Sectoral Collaboration: Collaboration between the health, education, community, and other relevant sectors enhances the reach and implementation of HPV vaccination programs. This is particularly important for school-based vaccination, where effective coordination between health authorities and educational institutions is required to identify eligible adolescents, communicate with parents, organize vaccination sessions, and monitor program delivery. Evidence from Tanzania demonstrates the feasibility of integrating HPV vaccination with adolescent health services through a school-based platform and highlights the importance of stakeholder collaboration [51,54]. National HPV vaccine introduction experiences across African countries likewise demonstrate the importance of collaboration among government institutions, health-sector stakeholders, schools, communities, and development partners [3]. South African evidence also identifies integration with adolescent health services as an important programme opportunity [9].

Inclusion of HPV Vaccination in National Immunization Programs: Formal adoption of HPV vaccination within national immunization programs provides an institutional framework for routine delivery, program coordination, financing, monitoring, and long-term sustainability. Evidence from African countries demonstrates the importance of national introduction and integration of HPV vaccination into existing immunization systems [3]. The South African experience provides evidence from a national school-based HPV vaccination program and illustrates the importance of national programme structures in implementing vaccination at scale [55]. Broader evidence on HPV vaccination acceleration in sub-Saharan Africa also highlights national program introduction as an important component of expanding vaccination coverage across the region [4,124].

Supportive Regulatory Environment: An efficient and supportive regulatory environment can facilitate timely vaccine registration, procurement, introduction, and program implementation. National experiences of HPV vaccine introduction in African countries indicate that regulatory, policy, procurement, and program-preparation processes can influence the timing and effectiveness of vaccine introduction [3]. Evidence on scaling HPV vaccination in Africa further underscores the importance of coordinated national systems and enabling policy environments for accelerating vaccine introduction and coverage [4].

Expanded Target Populations: More inclusive vaccination strategies can improve equity by **reaching** adolescents who may be missed by conventional school-based programs. Out-of-school adolescents represent an important population because school-based delivery may not reach them effectively; evidence from Kenya and reviews of HPV vaccine delivery strategies specifically highlights the need for alternative approaches for hard-to-reach and out-of-school girls [25,117]. Research among adolescents living with HIV in Uganda and Malawi demonstrates that these populations may have specific barriers and programme needs requiring tailored strategies [88,89]. Studies from Kenya, South Africa, and Uganda further demonstrate the importance of addressing age, geographic, and access-related disparities in HPV vaccination [14,22,60]. Inclusive approaches may also involve gender-neutral vaccination and other adaptations to national delivery strategies. Evidence from Cameroon has examined gender-neutral HPV vaccination and community engagement as approaches to improving vaccination coverage [74,75]. Thus, expanding or adapting target populations and delivery strategies can potentially improve equity and coverage, although the specific effect of each policy expansion should be evaluated within its implementation context.

Vaccine Uptake Patterns and Rates

Vaccine uptake rates varied widely across studies and settings, reflecting the influence of multiple barriers and facilitators:

Overall Uptake Rates: Reported HPV vaccine uptake rates varied substantially across countries and study settings, reflecting differences in program implementation, population characteristics, acces-

sibility, and measurement approaches. Evidence synthesized across sub-Saharan Africa demonstrates considerable variation in HPV vaccination uptake between and within countries [1,6]. Ethiopian studies have reported substantial variation in uptake, with knowledge, attitudes, socioeconomic characteristics, and access to vaccination services identified among important determinants [7]. Nigerian studies have similarly reported low and variable uptake, with barriers including limited awareness, parental concerns, vaccine hesitancy, and programme-delivery challenges [33,35,105]. In Uganda, studies have reported considerable variation in HPV vaccine uptake across districts and populations [16,17,113].

School-Based Versus Facility-Based Programs: School-based vaccination was an important delivery strategy for reaching adolescent girls and achieving high vaccination coverage. Studies from Tanzania, Uganda, South Africa, and Cameroon documented the feasibility and effectiveness of school-based HPV vaccination programs [51,62,73,113]. The South African national program evaluation demonstrated the feasibility of large-scale school-based HPV vaccination, while studies in Tanzania and Uganda similarly documented school-based delivery as an important mechanism for reaching eligible adolescents [51,55,113]. Evidence from Cameroon also demonstrates the potential for school-based campaigns, particularly when supported by community engagement [73]. School-based delivery offers several potential advantages, including convenience, the ability to reach large numbers of adolescents in a concentrated setting, and reduced geographic barriers to vaccination [92,115,125]. However, school-based programmes may fail to reach adolescents who are out of school, making complementary delivery strategies necessary [117].

Dose Completion: Completion of subsequent HPV vaccine doses was frequently lower than initial vaccination. In Tanzania, low uptake of the second HPV vaccine dose was specifically documented among adolescent girls [53]. Evidence from implementation studies indicates that maintaining high coverage requires strategies that address missed opportunities, follow-up, communication, access, and programme continuity [3,94,113]. Thus, improving HPV vaccination programmes requires attention not only to initiation but also to completion of the recommended vaccination schedule.

Urban-Rural Disparities: Geographical differences in HPV vaccination uptake were evident in several settings. Ethiopian research identified residence and access-related characteristics among factors associated with vaccination uptake [7,37]. In Uganda, rural residence and health-service access were associated with lower HPV vaccination uptake in several studies [14,15,111]. Health-system research from Uganda further demonstrated the importance of service availability and accessibility in determining HPV vaccination uptake [9]. The observed urban-rural differences may reflect disparities in access to information, schools, health facilities, vaccination services, transportation, and programme infrastructure. Evidence synthesized across sub-Saharan Africa similarly identifies geographic accessibility and social determinants as important influences on HPV vaccination

uptake [5,6,91]. Socioeconomic Disparities: Socioeconomic circumstances were associated with differences in HPV vaccination uptake.

Evidence from low- and middle-income countries indicates that household socioeconomic status, parental education, wealth, and related social determinants can influence access to and acceptance of HPV vaccination [91]. Ethiopian studies have similarly examined socioeconomic and demographic characteristics as determinants of HPV vaccination uptake [7,15]. Regional evidence from sub-Saharan Africa further indicates that socioeconomic inequalities can contribute to differences in vaccination coverage [5,6].

Special Populations: HPV vaccination uptake among special and vulnerable populations varied according to context. Studies involving adolescents living with HIV in Uganda and Malawi identified specific barriers and facilitators affecting vaccination uptake and completion [88,89]. Research in Uganda also examined HPV vaccine uptake among adolescent girls and young women living with HIV, demonstrating the importance of understanding the needs of this population within vaccination programs [100]. Evidence from Côte d'Ivoire further indicates that HPV vaccination uptake among adolescent girls living with HIV can be assessed at the national level [81]. For out-of-school adolescents, conventional school-based programs may create important access gaps. Research in Kenya has documented challenges in reaching hard-to-reach populations [25,26], while a recent review specifically examined delivery strategies designed to reach out-of-school girls in low- and middle-income countries [117]. Therefore, alternative or complementary delivery strategies may be required to improve equitable coverage among adolescents who are not reached through schools.

Temporal Trends: HPV vaccination programs have evolved over time as countries have introduced, expanded, and modified their vaccination strategies. Multi-country evidence examining HPV vaccination acceleration and introduction in sub-Saharan Africa demonstrates changes in program implementation over time [4]. National program experiences also indicate that program maturity, implementation learning, stakeholder engagement, and sustainability mechanisms influence vaccination coverage [3,94]. However, coverage may be affected by continuing challenges such as vaccine supply, health-system constraints, changing delivery strategies, and programme sustainability [122,123]. Relationship Between Barriers, Facilitators, and Uptake: The evidence indicates that HPV vaccination uptake is influenced by the interaction of individual, interpersonal, community, health-system, and policy-level factors. Strategies addressing several barriers simultaneously may be more effective than isolated interventions. School-based delivery, community engagement, effective communication, stakeholder involvement, and supportive program implementation have all been identified as important components of successful HPV vaccination programs [3,73,94].

Communication interventions have also been examined as strategies for improving HPV immunization uptake among adolescents in

sub-Saharan Africa [93]. Peer-to-peer education has demonstrated potential for improving vaccine acceptance among adolescent girls in Uganda [104], while interventions involving healthcare workers and community stakeholders can address information gaps and vaccine concerns [19,119]. Conversely, settings characterized by multiple unresolved barriers, including poor access, vaccine hesitancy, misinformation, weak health-system capacity, and inadequate program implementation, may experience persistently low uptake [14,34-36]. Overall, the evidence suggests that achieving high and equitable HPV vaccination coverage requires coordinated interventions operating across multiple levels rather than reliance on a single strategy.

Discussion

This systematic review synthesized evidence from 222 studies examining barriers and facilitators to HPV vaccine uptake among adolescents in sub-Saharan Africa. The findings reveal a complex, multi-level landscape of factors influencing vaccination, with implications for policy and practice.

Individual-Level Findings

At the individual level, knowledge emerged as an important determinant of HPV vaccination acceptance and uptake. Studies among adolescents and parents in Ethiopia, Uganda, Nigeria, and other sub-Saharan African settings found that knowledge about HPV, cervical cancer, and HPV vaccination was associated with more favorable vaccination attitudes and acceptance [7,15,38,46,126,127]. Conversely, knowledge gaps, misconceptions, and inaccurate beliefs about HPV vaccination represented important barriers to acceptance [8,34,36,39,57,108]. Concerns about vaccine safety and adverse effects, including fears relating to infertility, were also documented in several settings [34,36,39,53,58,107]. These findings underscore the importance of evidence-based education and communication strategies that address context-specific concerns and misconceptions [1,93].

Positive attitudes toward HPV vaccination, recognition of vaccine benefits, and perceptions concerning susceptibility to HPV infection were also associated with greater willingness to vaccinate and vaccine uptake. Evidence from Ethiopia, Uganda, Ghana, and Nigeria indicates that attitudes, perceived benefits, risk perceptions, and other behavioral determinants influence HPV vaccination decisions [7,15,46,65,97]. These findings are consistent with the Health Belief Model, which conceptualizes health behaviour in relation to perceived susceptibility, perceived severity, perceived benefits, and perceived barriers. The Health Belief Model was explicitly applied in research examining parental consent to HPV vaccination in Zambia [92]. Accordingly, interventions that increase understanding of HPV risk and vaccine benefits while reducing perceived barriers may contribute to improved vaccination acceptance.

Community-Level Findings

Community-level factors exerted substantial influence on HPV

vaccination decisions. Parental attitudes, knowledge, beliefs, and willingness to vaccinate were particularly important because parents and caregivers frequently influence vaccination decisions for adolescent girls [27,33,41,45,98,99,126,128]. These findings highlight the importance of targeting parents and caregivers with tailored education, transparent communication, and opportunities to address concerns about HPV vaccination. Cultural beliefs, religious concerns, stigma surrounding sexual health, and prevailing social norms shaped vaccination attitudes in complex ways. Studies from Uganda, Ethiopia, Nigeria, and other sub-Saharan African settings documented how socio-cultural beliefs and interpretations of HPV, cervical cancer, sexuality, and vaccination could influence acceptance [8,90,109,110]. Religious and community beliefs could also contribute to vaccine hesitancy where HPV vaccination was interpreted through concerns about sexual behaviour or morality [36,72,109].

Conversely, engagement of trusted community stakeholders can help address cultural concerns and build confidence in vaccination programs [73,75]. Misinformation and rumors, particularly concerning vaccine safety, infertility, and other alleged adverse effects, were important barriers to HPV vaccination. Evidence from South Africa, Ethiopia, Nigeria, and broader sub-Saharan African reviews demonstrates how misinformation can undermine confidence and contribute to vaccine hesitancy [34,36,57,107,108]. Communication interventions and trusted information channels are therefore important components of HPV vaccination programmes [1,93].

Health System-Level Findings

Health-system factors were critical determinants of HPV vaccine access and implementation. School-based vaccination was an important delivery strategy because it enabled programs to reach large numbers of eligible adolescents within schools and could reduce some geographical and access barriers [51,55,62,113]. Evidence from implementation and scoping reviews similarly identifies school-based platforms as important strategies for reaching adolescent girls [92,125]. However, the retained evidence does not justify describing school-based delivery as universally “the most effective” strategy or as consistently superior to facility-based delivery across all settings. Its effectiveness depends on program organization, school attendance, vaccine availability, community acceptance, and implementation context [9,94]. School-based programmes alone are insufficient to achieve equitable coverage because adolescents who are out of school may not be reached. Evidence from Kenya and other settings identifies challenges in reaching hard-to-reach populations, while recent evidence specifically considers delivery approaches for out-of-school girls [25,117]. Complementary approaches, including outreach and alternative delivery strategies, may therefore be required to reach underserved populations.

Healthcare-provider recommendations and communication also influenced HPV vaccination decisions. Research from Nigeria identified factors affecting healthcare workers’ recommendations of HPV vaccination, while studies in Uganda and other settings highlighted

the roles of healthcare workers, community health workers, caregivers, and teachers in HPV vaccination implementation [10,19]. Healthcare-worker knowledge, confidence, and communication skills are therefore important considerations when designing strategies to address vaccine hesitancy [9,119]. Vaccine availability and health-system capacity also affected HPV vaccination implementation. Studies from Nigeria, Tanzania, Uganda, and Zambia identified supply, service-delivery, logistical, and broader health-system constraints that could limit access to vaccination [11,32,50,92]. Regional evidence similarly identifies health-system capacity, infrastructure, programme organization, and resource availability as important determinants of successful HPV vaccination implementation [94,122].

Policy-Level Findings

Policy-level factors shaped the enabling environment for HPV vaccination programs. Evidence from national HPV vaccine introductions in African countries demonstrates the importance of political and program leadership, stakeholder engagement, program planning, and national commitment to successful implementation [3]. Rwanda's experience similarly provides lessons concerning vaccine implementation and program effectiveness [78]. Evidence from Tanzania further demonstrates the importance of engagement across national, sub-national, and community levels in supporting implementation [50]. Adequate financing and resource allocation are important for vaccine procurement, program implementation, workforce development, communication, logistics, monitoring, and sustainability. Evidence from African HPV vaccination programs and implementation studies highlights the importance of adequate resources and health-system capacity [3,92,94,122,123]. Clear policy and implementation frameworks can facilitate coordinated program delivery. National introduction experiences and implementation research emphasize program planning, coordination, defined implementation responsibilities, and contextually appropriate implementation strategies [3,92,94].

Integration with existing immunization and adolescent health services can further strengthen program delivery. Evidence from South Africa, Tanzania, and Togo demonstrates the potential value of integrating HPV vaccination with adolescent health and existing service platforms [9,54,114]. Multi-sectoral collaboration, particularly between health and education sectors, is also important for school-based vaccination. Effective collaboration can support identification of eligible adolescents, communication with parents, organization of vaccination sessions, and program monitoring [3,51,54]. National adoption of HPV vaccination and its integration within national immunization systems can provide an institutional basis for program coordination and scale-up [4,55]. Finally, policies and delivery strategies that account for underserved populations can improve equity. Out-of-school adolescents may require complementary delivery approaches, while adolescents living with HIV may require tailored strategies reflecting their specific circumstances [88,89,100,117]. Gender-neutral vaccination approaches have also been explored as a strategy for expanding coverage in Cameroon [74,75].

Relationship Between Barriers, Facilitators, and Uptake

The evidence demonstrates that HPV vaccination uptake is shaped by interactions among individual, interpersonal, community, health-system, and policy factors. Programs that combine several complementary strategies may be better positioned to address the multiple barriers affecting vaccination acceptance and access. Evidence from African HPV vaccination programs indicates the importance of combining education and communication, community and stakeholder engagement, appropriate delivery platforms, health-system strengthening, and effective programme coordination [3,73,94]. Communication and education interventions can address knowledge gaps and misinformation, while peer education and community engagement can strengthen social support and trust [93,104]. School-based delivery can improve access to in-school adolescents, whereas outreach and alternative delivery approaches can help address the needs of out-of-school and hard-to-reach populations [25,117].

Healthcare-worker capacity, reliable vaccine supply, and supportive implementation systems are additional requirements for translating vaccine acceptance into actual uptake [10,11,50]. Conversely, settings in which several barriers remain unresolved, including misinformation, parental hesitancy, poor accessibility, health-system constraints, and inadequate programme implementation, may experience low vaccination uptake [14,34,36]. Overall, the retained evidence supports a multi-level approach to HPV vaccination rather than reliance on a single intervention. High and equitable coverage is more likely when interventions simultaneously address knowledge and attitudes, parental and community influences, service-delivery barriers, health-system capacity, and the policy environment.

Implications for Policy and Practice

The findings have several important implications for HPV vaccination policy, programme planning, and implementation in sub-Saharan Africa:

Prioritize school-based vaccination delivery while providing complementary approaches for out-of-school adolescents: School-based delivery provides an important platform for reaching large numbers of eligible adolescents efficiently and has been successfully implemented in several African settings [51,55,62,113]. However, because school-based programmes may not adequately reach out-of-school adolescents, complementary approaches are needed to improve equity and coverage among underserved populations [25,117].

Invest in comprehensive education and communication strategies: Education and communication interventions should address knowledge gaps, misconceptions, vaccine safety concerns, and misinformation while building confidence among adolescents, parents, and communities. Evidence from sub-Saharan Africa supports communication interventions as an important strategy for improving HPV immunization uptake [1,8,93]. Studies involving parents and

caregivers also demonstrate the importance of providing accurate information to support informed vaccination decisions [33,41].

Engage cultural, religious, and community leaders as trusted vaccination advocates: Engagement of trusted community stakeholders can help address culturally specific concerns, counter misinformation, and strengthen community acceptance of HPV vaccination. Evidence from Cameroon demonstrates the importance of community engagement in successful vaccination campaigns, while broader African evidence supports stakeholder involvement in programme implementation [73,75]. Qualitative and review evidence further indicates that trusted community actors can contribute to addressing sociocultural concerns surrounding HPV vaccination [1,8].

Strengthen health systems, including healthcare-worker capacity, vaccine supply, logistics, and service-delivery infrastructure: Health-system strengthening should include appropriate training and support for healthcare workers, reliable vaccine availability, effective logistics, and adequate service-delivery capacity. Healthcare-worker knowledge and communication are important to HPV vaccination implementation [10,12], while studies from Tanzania, Uganda, and Zambia identify broader health-system and implementation constraints that can affect vaccination delivery [11,50,92]. Regional evidence further supports health-system strengthening as an important component of successful HPV immunization programs [94,122]. Ensure adequate and sustainable funding for vaccine procurement and programme implementation: Sustainable financing is required to support vaccine procurement, program operations, communication, logistics, workforce development, monitoring, and long-term implementation. Evidence from African HPV vaccine introductions and implementation studies highlights the importance of adequate program resources and sustainable implementation capacity [3,92,94,122].

Develop clear policy frameworks that support multisectoral collaboration, program integration, and inclusive delivery: National policies and implementation frameworks should clearly define program responsibilities and facilitate collaboration among health, education, community, and other relevant sectors. Evidence from national HPV vaccine introductions and implementation research supports coordinated program planning and multisectoral collaboration [3,51,92]. Integration with adolescent health services can further strengthen programme delivery [9,54]. Policies should also incorporate strategies for reaching populations that may be missed by school-based programs, including out-of-school adolescents [117]. Implement robust monitoring and evaluation systems: Strong monitoring and evaluation systems are needed to track vaccination coverage, identify missed populations and implementation gaps, monitor program performance, and support timely corrective action. Evidence from national HPV vaccination programmes and implementation research highlights the importance of monitoring, coordination, data use, and program evaluation in achieving and sustaining vaccination coverage [3,55,92,94].

Address misinformation proactively through transparent communication, community engagement, and credible messengers: HPV vaccination programmes should proactively identify and address misinformation concerning vaccine safety, fertility, sexuality, and other perceived risks. Evidence from Ethiopia, South Africa, Nigeria, and broader sub-Saharan Africa demonstrates that rumours and misinformation can undermine vaccine confidence and contribute to hesitancy [34,36,57,107]. Communication strategies, trusted messengers, and community engagement can help provide accurate information and strengthen confidence in HPV vaccination [1,8,93,129-208].

Limitations

This systematic review has several limitations that should be considered when interpreting the findings:

Limitations of Included Studies

Study Design Heterogeneity: The included studies employed diverse methodological approaches, including cross-sectional surveys, qualitative studies, mixed-methods research, and systematic reviews. This heterogeneity limited the ability to conduct meta-analyses for some outcomes and may affect the comparability of findings across studies.

Geographic Representation

While the review included studies from 12 sub-Saharan African countries, representation was uneven, with some countries (e.g., Uganda, Ethiopia, Kenya, Nigeria) heavily represented and others (e.g., Mozambique, Botswana, Rwanda) represented by single studies. Findings may not be generalizable to countries with limited or no representation in the literature. **Publication Bias:** The review included only published and preprint studies available through the searched databases. Unpublished studies, grey literature, and studies published in languages other than English may have been missed, potentially introducing publication bias.

Temporal Variation

Studies were conducted at different time points and stages of HPV vaccination program implementation, from pilot projects to mature national programs. Temporal variation in program maturity, vaccine availability, and policy contexts may affect the comparability of findings. **Measurement Heterogeneity:** Studies used diverse measures of vaccine uptake, including self-reported vaccination, documented vaccination records, initiation of vaccination, and completion of the vaccine series. This measurement heterogeneity complicated the synthesis of uptake rates across studies.

Quality Variation

While quality assessment was conducted, the included studies varied in methodological rigor, sample size, and representativeness. Some studies had small sample sizes or were conducted in specific settings (e.g., single schools or health facilities), limiting generaliz-

ability. Reporting Limitations: Some studies provided limited detail on specific barriers and facilitators, making it difficult to extract nuanced information about mechanisms and contextual factors.

Limitations of the Review Methodology

AI-Assisted Screening: While AI-assisted screening provided consistency and reduced reviewer bias, it may have introduced different biases or missed nuances that human reviewers would have captured. However, the two-stage screening process with increasing stringency thresholds aimed to mitigate this limitation.

Language Restriction

The search was limited to studies published in English, potentially excluding relevant studies published in French, Portuguese, or other languages common in sub-Saharan Africa. Database Coverage: While three major databases were searched, some relevant studies indexed in other databases or repositories may have been missed.

Data Extraction

Data extraction was performed using AI-assisted methodology with access to full-text PDFs where available. For studies without accessible full text, extraction relied on abstracts and available metadata, which may have limited the depth of information captured.

Synthesis Approach

The review employed narrative synthesis rather than meta-analysis for most outcomes due to heterogeneity in study designs, measures, and contexts. While narrative synthesis provides comprehensive understanding, it is more subjective than quantitative synthesis.

Limitations in Addressing Research Questions

Causal Inference

Most included studies were cross-sectional or qualitative, limiting the ability to establish causal relationships between barriers, facilitators, and vaccine uptake. Longitudinal and intervention studies are needed to establish causality.

Interaction Effects

The review identified barriers and facilitators at multiple levels but had limited ability to examine interactions between factors across levels. Understanding how individual, community, health system, and policy factors interact to influence uptake requires more sophisticated analytical approaches.

Context-Specific Factors

While the review identified common barriers and facilitators across settings, context-specific factors that may be critical in particular countries or communities may not have been fully captured. Despite these limitations, this systematic review provides the most comprehensive synthesis to date of barriers and facilitators to HPV vaccine uptake among adolescents in sub-Saharan Africa, drawing on

evidence from 222 studies across 12 countries. The findings provide valuable insights for policymakers, program implementers, and researchers working to improve HPV vaccination coverage in the region.

Conclusion

This systematic review provides comprehensive evidence on the multi-level barriers and facilitators influencing HPV vaccine uptake among adolescents in sub-Saharan Africa. Drawing on 222 studies across 12 countries, the review demonstrates that vaccine uptake is shaped by complex interactions between individual, community, health system, and policy-level factors. Lack of knowledge about HPV, cervical cancer, and the vaccine represents a fundamental barrier, while good knowledge is a strong facilitator of uptake. Evidence-based education targeting adolescents, parents, and communities is essential. Also, myths, rumors, and misinformation about vaccine safety and effects, particularly regarding infertility, significantly hinder uptake. Proactive, transparent communication strategies using credible messengers are needed to build trust and counter misinformation. School-based vaccination programs consistently achieve higher coverage than facility-based approaches, providing convenience, efficiency, and reduced access barriers. School-based delivery should be the primary implementation strategy. School-based programs alone exclude out-of-school adolescents, who represent a vulnerable population with lower coverage. Outreach services, facility-based vaccination, and community-based approaches are needed to achieve equitable coverage. Similarly, engaging parents, cultural leaders, religious leaders, and community members as vaccination champions addresses community-level concerns and builds social support.

Culturally sensitive, community-engaged approaches are essential. Also, healthcare worker training, reliable vaccine supply, strengthened supply chains, and improved service delivery infrastructure are necessary to ensure vaccine access and quality services. Not that alone, strong political commitment, adequate funding, clear policy frameworks, multi-sectoral collaboration, and integration with existing programs create the enabling environment for successful vaccination programs. Programs that address barriers and leverage facilitators across multiple levels achieve the highest coverage. Single-component interventions are insufficient; comprehensive strategies are required.

Recommendations for Improving HPV Vaccine Uptake

Based on the evidence synthesized in this review, we recommend the following strategies to improve HPV vaccine uptake in sub-Saharan Africa:

For Policy-Makers:

- a) Prioritize HPV vaccination as a national health priority with sustained political commitment and adequate domestic funding.

- b)** Develop and implement clear national policies, guidelines, and standard operating procedures for HPV vaccination.
- c)** Ensure formal inclusion of HPV vaccination in national immunization programs and essential health packages.
- d)** Expand target population definitions to include out-of-school adolescents, older age groups, and special populations.
- e)** Foster multi-sectoral collaboration, particularly between health and education sectors, to support school-based programs.
- f)** Invest in health system strengthening, including healthcare worker capacity building, supply chain management, and infrastructure development.
- g)** Allocate resources for comprehensive communication and community engagement strategies.
- h)** Establish robust monitoring and evaluation systems to track coverage, identify gaps, and enable timely interventions.

For Program Implementers:

- a.** Implement school-based vaccination as the primary delivery strategy, ensuring coordination with education authorities.
- b.** Develop complementary strategies to reach out-of-school adolescents, including outreach services and facility-based vaccination.
- c.** Conduct comprehensive education and awareness campaigns targeting adolescents, parents, teachers, and communities.
- d.** Engage cultural and religious leaders as vaccination champions to address community-level concerns.
- e.** Train healthcare workers on HPV vaccination, communication skills, and strategies to address vaccine hesitancy.
- f.** Ensure reliable vaccine supply through strengthened supply chain management and cold chain maintenance.
- g.** Implement strategies to improve vaccine series completion, including reminder systems and follow-up mechanisms.
- h.** Address misinformation proactively through transparent communication and credible messengers.
- i.** Integrate HPV vaccination with other adolescent health services to improve efficiency and coverage.
- 1)** Monitor coverage continuously and implement targeted interventions to address gaps and reach underserved populations.

For Researchers:

- a)** Conduct implementation research to identify effective strategies for scaling up HPV vaccination programs and ensuring sustainability.

- b)** Examine long-term outcomes of vaccination programs, including sustained coverage, equity, and impact on cervical cancer incidence.
- c)** Investigate effective approaches to reach hard-to-reach populations, including out-of-school adolescents, rural communities, and special populations.
- d)** Evaluate the effectiveness of different communication strategies in addressing misinformation and building trust.
- e)** Examine the cost-effectiveness of different delivery models and implementation strategies.
- f)** Investigate the role of gender-neutral vaccination approaches and their acceptability in sub-Saharan African contexts.
- g)** Conduct longitudinal studies to establish causal relationships between barriers, facilitators, and vaccine uptake.
- h)** Examine interactions between factors at different levels and their combined effects on uptake.
- i)** Investigate the role of emerging technologies, including digital health tools and social media, in promoting vaccination.
- j)** Conduct research in countries and populations currently underrepresented in the literature.

Gaps and Future Research Directions

Several important gaps remain in the evidence base:

- Most studies examined programs in early implementation stages. Long-term sustainability of high coverage and program financing requires further investigation.
- While recognized as a vulnerable population, effective strategies to reach out-of-school adolescents remain understudied.
- More research is needed on HPV vaccination among adolescents living with HIV, adolescents with disabilities, and other special populations.
- Several sub-Saharan African countries are underrepresented or absent from the literature. Research in these settings is needed to understand context-specific factors.
- More research is needed on implementation strategies, scale-up approaches, and factors influencing program sustainability.
- While some studies examined gender-neutral approaches, evidence on male HPV vaccination in sub-Saharan Africa remains limited.
- More research is needed on strategies to reduce disparities in coverage by socioeconomic status, geographic location, and other equity dimensions.
- Cost-effectiveness analyses of different delivery models and

implementation strategies are needed to inform resource allocation decisions.

Achieving high and equitable HPV vaccine coverage among adolescents in sub-Saharan Africa is feasible but requires comprehensive, multi-level strategies that address the complex barriers identified in this review while leveraging facilitators. The evidence demonstrates that when programs combine school-based delivery, community engagement, healthcare worker training, reliable vaccine supply, and strong policy support, high coverage can be achieved. With sustained commitment, adequate resources, and evidence-based implementation, HPV vaccination can make a substantial contribution to cervical cancer prevention and the health of adolescent girls in sub-Saharan Africa.

Declaration of AI Use

This manuscript was developed through the collective intellectual contributions of all authors, who participated in the conception and design of the study, literature review, data interpretation, content development, analysis of findings, and critical revision of the manuscript. SciSpace was used to facilitate the screening and organisation of relevant literature during the review process. Quillbot, PaperPal, and ChatGPT were used solely to assist with language editing, grammatical refinement, clarity of expression, and reference formatting. These artificial intelligence (AI) tools served only as supportive resources and did not contribute as authors, nor did they replace the authors' independent scientific judgment, critical appraisal, interpretation of evidence, or scholarly decision-making. All AI-assisted outputs, including screened literature, edited text, references, and interpretations, were carefully reviewed, verified, revised where necessary, and approved by the authors. The authors accept full responsibility for the accuracy, integrity, authenticity, and final content of the manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest.

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